1. (d).
2. (a).
3. (b).
5. (a) The kinetic energy of the approaching proton **decreases** as its electric potential energy increases since its total energy is constant.

   (b) The electric potential energy of the system **increases**, because the distance between the charges decreases.

   (c) The total energy of the system **remains the same** because of the conservation of energy.

7. It will move **to the right** or toward the higher potential region, because the electron has negative charge. The higher the potential region, for the electron, the lower the potential energy.

12. From $W = q\Delta V = qEd$,

$$E = \frac{W}{qd} = \frac{\Delta V}{d} = \frac{6.0\text{ V}}{4.0\times10^{-3}\text{ m}} = \boxed{1.5\times10^{3}\text{ V/m pointing from positive to negative}}.$$

13. $W = q\Delta V = \Delta K = K - K_o = K = (1.60\times10^{-19}\text{ C})(10\times10^{3}\text{ V}) = \boxed{1.6\times10^{-15}\text{ J}}$.

17. (a) The electric potential will change by a factor of 3, because electric potential is inversely proportional to the distance, $V = \frac{kq}{r}$. So the answer is **(2) 3**.

(b) $V = \frac{kq}{r}$, ☞ $r = \frac{kq}{V} = \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(1.0\times10^{-6}\text{ C})}{10\times10^{3}\text{ V}} = \boxed{0.90\text{ m}}$.

(c) $$\Delta V = \frac{kq}{r_B} - \frac{kq}{r_A} = \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(1.0\times10^{-6}\text{ C})}{3(0.90\text{ m})} - \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(1.0\times10^{-6}\text{ C})}{0.90\text{ m}}$$

$= -6.7\times10^{-3}\text{ V} = \boxed{-6.7\text{ kV}}$. Since the potential difference is negative, it is a potential decrease.

23. (a) $$W = \Delta U_e = \frac{kq_1q_2}{r_2} - \frac{kq_1q_2}{r_1} = \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(-5.0\times10^{-6}\text{ C})(2.0\times10^{-6}\text{ C})}{0.50\text{ m}}$$

$$-\frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(-5.0\times10^{-6}\text{ C})(2.0\times10^{-6}\text{ C})}{0.20\text{ m}} = \boxed{+0.27\text{ J}}.$$

(b) **No**, since electric force is a conservative force.

28. (a) The distance from the charges to the square center is $r = \sqrt{(0.05\text{ m})^2 + (0.05\text{ m})^2} = 0.0707\text{ m}$.

$$V = \Sigma\frac{kq}{r} = 2\,\frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(-10\times10^{-6}\text{ C})}{0.0707\text{ m}} + 2\,\frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(5.0\times10^{-6}\text{ C})}{0.0707\text{ m}} = \boxed{-1.3\times10^{6}\text{ V}}$$

(b) The distance from q_2 and q_3 to the point is

$r = \sqrt{(0.10\text{ m})^2 + (0.05\text{ m})^2} = 0.112\text{ m}$.

$$V = \Sigma\frac{kq}{r} = \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(-10\times10^{-6}\text{ C})}{0.05\text{ m}} + \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(-10\times10^{-6}\text{ C})}{0.112\text{ m}}$$

$$+\frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(5.0\times10^{-6}\text{ C})}{0.112\text{ m}} + \frac{(9.0\times10^{9}\text{ N}\cdot\text{m}^2/\text{C}^2)(5.0\times10^{-6}\text{ C})}{0.05\text{ m}} = \boxed{-1.3\times10^{6}\text{ V}}.$$

30. (a).

31. (b).

32. (b).

36. They are $\boxed{\text{planes, parallel to the plates}}$.

41. $V = \dfrac{kq}{r}$, ☞ $r = \dfrac{kq}{V} = \dfrac{(9.0 \times 10^{9}\ \text{N·m}^2/\text{C}^2)(3.50 \times 10^{-6}\ \text{C})}{2.50 \times 10^{3}\ \text{V}} = \boxed{12.6\ \text{m}}$.

$\boxed{42}$. $E = \dfrac{\Delta V}{\Delta x}$, ☞ $\Delta x = \dfrac{\Delta V}{E} = \dfrac{10\ \text{V}}{100\ \text{V/m}} = 10^{-2}\ \text{m} = \boxed{1.0\ \text{cm}}$.

$\boxed{48}$. $W = \Delta K = K - K_o = K = -\Delta U_e = -q\Delta V = e\Delta V = e(100 \times 10^{6}\ \text{V}) = \boxed{1.00 \times 10^{8}\ \text{eV}}$.

$(1.00 \times 10^{8}\ \text{eV}) \times \dfrac{1.60 \times 10^{-19}\ \text{J}}{1\ \text{eV}} = \boxed{1.60 \times 10^{-11}\ \text{J}}$.

57. (c). Capacitance does not depend on voltage.

58. (a). Charge depends on voltage.

59. (a). The voltage doubles, so the electric field also doubles.

60. (c), because $C = \dfrac{\varepsilon_o A}{d}$.

61. (b).

67. $C = \dfrac{\varepsilon_o A}{d}$, ☞ $d = \dfrac{\varepsilon_o A}{C} = \dfrac{(8.85 \times 10^{-12}\ \text{F/m})(0.40\ \text{m}^2)}{5.0 \times 10^{-9}\ \text{F}} = \boxed{0.71\ \text{mm}}$.

$\boxed{68}$. (a) A large plate area results in $\boxed{\text{(1) a larger}}$ capacitance, because capacitance is directly proportional to the plate area, $C = \varepsilon_o A/d$.

(b) $C = \dfrac{\varepsilon_o A}{d}$, ☞ $\dfrac{A_2}{A_1} = \dfrac{C_2}{C_1}$. So $A_2 = \dfrac{C_2}{C_1} A_1 = 2(0.425\ \text{m}^2) = \boxed{0.850\ \text{m}^2}$.

74. (b).

75. (d), because the dielectric increases the capacitance and, therefore, the charge.

76. (c).

80. $\kappa = \dfrac{C}{C_o} = \dfrac{150\ \text{pF}}{50\ \text{pF}} = \boxed{3.0}$.

81. $Q = CV = \kappa C_o V = 2.6(50 \times 10^{-12}\ \text{F})(24\ \text{V}) = \boxed{3.1 \times 10^{-9}\ \text{C}}$,

$U_C = \frac{1}{2} CV^2 = \frac{1}{2} \kappa C_o V^2 = \frac{1}{2} 2.6(50 \times 10^{-12}\ \text{C})(24\ \text{V})^2 = \boxed{3.7 \times 10^{-8}\ \text{J}}$.

85. (b).

86. (a).

87. (b). Two in series have an equivalent of $0.5C$.
Then the parallel combination gives $C + 0.5C = 1.5C$.

88. They have the same voltage when they have $\boxed{\text{equal capacitance}}$.

89. They have the same charge when they have $\boxed{\text{equal capacitance}}$.

$\boxed{90}$. (a) Connect them in $\boxed{\text{parallel}}$ to get maximum equivalent capacitance.

(b) Connect them in $\boxed{\text{series}}$ to get minimum equivalent capacitance.

$\boxed{93}$. (a) The parallel combination will draw $\boxed{\text{(1) more}}$ energy from the battery, because the equivalent capacitance is higher, and the energy stored (drawn) is proportional to capacitance.

(b) $U_{\text{total}} = \frac{1}{2}C_s V^2$, ☞ $C_s = \dfrac{2U_{\text{total}}}{V^2} = \dfrac{2(173\ \mu\text{J})}{(12\ \text{V})^2} = 2.40\ \mu\text{F}$.

Also $\dfrac{1}{C_s} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$, ☞ $C_2 = \dfrac{C_1\,C_s}{C_1 - C_s} = \dfrac{(4.0\ \mu\text{C})(2.40\ \mu\text{F})}{4.0\ \mu\text{F} - 2.40\ \mu\text{F}} = \boxed{6.0\ \mu\text{F}}$.

94. All three are in parallel. So $C_p = C_1 + C_2 + C_3 = 1.7\ \mu\text{F}$.

Therefore $C_1 = 1.7\ \mu\text{F} - 0.20\ \mu\text{F} - 0.30\ \mu\text{F} = \boxed{1.2\ \mu\text{F}}$.